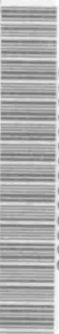


BEWIS

STANDARDS DEVELOPMENT BRANCH OMOE



36936000009092

MISSISSIPPI C
W.O. LIB
RICHMOND (ON)

REPORT ON WATER QUALITY IN SHARBOT LAKE

1972



Ontario

Ministry
of the
Environment

The Honourable
James A. C. Auld
minister

Everett Biggs
deputy minister

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact ServiceOntario Publications at copyright@ontario.ca

REPORT ON WATER QUALITY

in

SHARBOT LAKE

1972

GENERAL TABLE OF CONTENTS

List of Figures	ii
Preface	iii
Summary	v
Purpose of the Surveys	1
Design of the Surveys	2
Timing	2
Selection of Sample Locations	2
Field Tests	4
Bacteriological Tests	4
Chemical Tests	4
Description of Sharbot Lake Area	7
Lake and Soil Characteristics	7
Shoreline Development and Water Usage	8
Results and Discussion	9
Bacteriology	9
Chlorophyll <u>a</u> and Water Clarity	14
Chemistry	15
Future Considerations	21
Information of General Interest to Cottagers	
Microbiology of Water	A-1
Rainfall and Bacteria	A-2
Water Treatment	A-3
Septic Tank Installations	A-5
Dye Testing of Septic Tank Systems	A-5
Boating Regulations	A-6
Ice-Oriented Recreational Activities	A-7
Eutrophication or Excessive Fertilization and Lake Processes	A-8
Control of Aquatic Plants and Algae	A-9
Phosphorus and Detergents	A-11
Ontario's Phosphorus Removal Program	A-12
Control of Biting Insects	A-13

LIST OF FIGURES

Figure 1	Cottage Development and Contours of Sharbot Lake	3
Figure 2	Use of Secchi Disc to Determine Water Clarity.....	5
Figure 3	Distribution of Bacteria in Sharbot Lake in June	11
Figure 4	Distribution of Bacteria in Sharbot Lake in July	12
Figure 5	Distribution of Bacteria in Sharbot Lake in October	13
Figure 6	The Mean of Chlorophyll <u>a</u> and Secchi Disc Measurements in Sharbot Lake Relative to a Curve describing the Chlorophyll <u>a</u> - Secchi Disc Relationship in Many Ontario Lakes	16
Figure 7	Dissolved Oxygen and Temperature Profiles at Stations 5, 22, 28 and 31, June	17
Figure 8	Dissolved Oxygen and Temperature Profiles at Stations 5, 22, 28 and 31, August.....	18
Figure 9	Dissolved Oxygen and Temperature Profiles at Stations 5, 22, 28 and 31, October	19

PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and its surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried out by the Ministry:

1. Evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory;

2. Research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal;

3. Evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Sharbot Lake is one of a series dealing with the water quality aspects of the recreational lakes studied in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

A study to evaluate the present condition of the water quality in Sharbot Lake was carried out in the summer of 1972.

Sharbot Lake, located in the County of Frontenac, lies in the headwaters of the Fall River which makes up part of the Mississippi River watershed. The lake, covering a surface area of 15 square kilometers (3.725 acres), consists of two basins connected by a narrow channel. At the present time this 76-kilometer (47 mile) shoreline is settled by approximately 300 summer cottages, one public park and the Hamlet of Sharbot. Due to a combination of severe topography and swampy areas, most of the existing development has taken place in small clusters on those shores which have a moderate slope. The soil cover over bedrock around most of the lake was found to be too shallow for proper installation of standard sub-surface septic tank systems for use in disposal of domestic waste.

Generally, the bacteriological water quality was fairly good with FC and FS concentrations remaining low throughout the three surveys. There were, however, marked fluctuations in TC densities throughout the surveys varying from low densities in the early summer and fall to much higher densities in the midsummer.

Water chemistry data collected during the survey did not show any unusual mineral or nutrient concentrations. The main inlet stream was a major contributor of mineral constituents and nutrients which were generally present in several times greater concentration than in the main body of the lake.

Nutrient concentrations in the lake were generally low as were concentrations of suspended algae as measured by Chlorophyll a results.

The dissolved oxygen in the deep water of the lake was depleted during the summer months and therefore renders the lake unsuitable for cold water species of fish.

Previous work has mentioned algae blooms in Sharbot lake and any identifiable sources of waste input should be controlled in order to minimize algae and aquatic plant growth and the resulting oxygen demand in the bottom waters when this material decomposes.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae
- water quality with depth
- inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and of microscopic free-floating plants called algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses of the lake.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from June 7 to 11 , from July 31 to August 4 and from October 12 to 16.

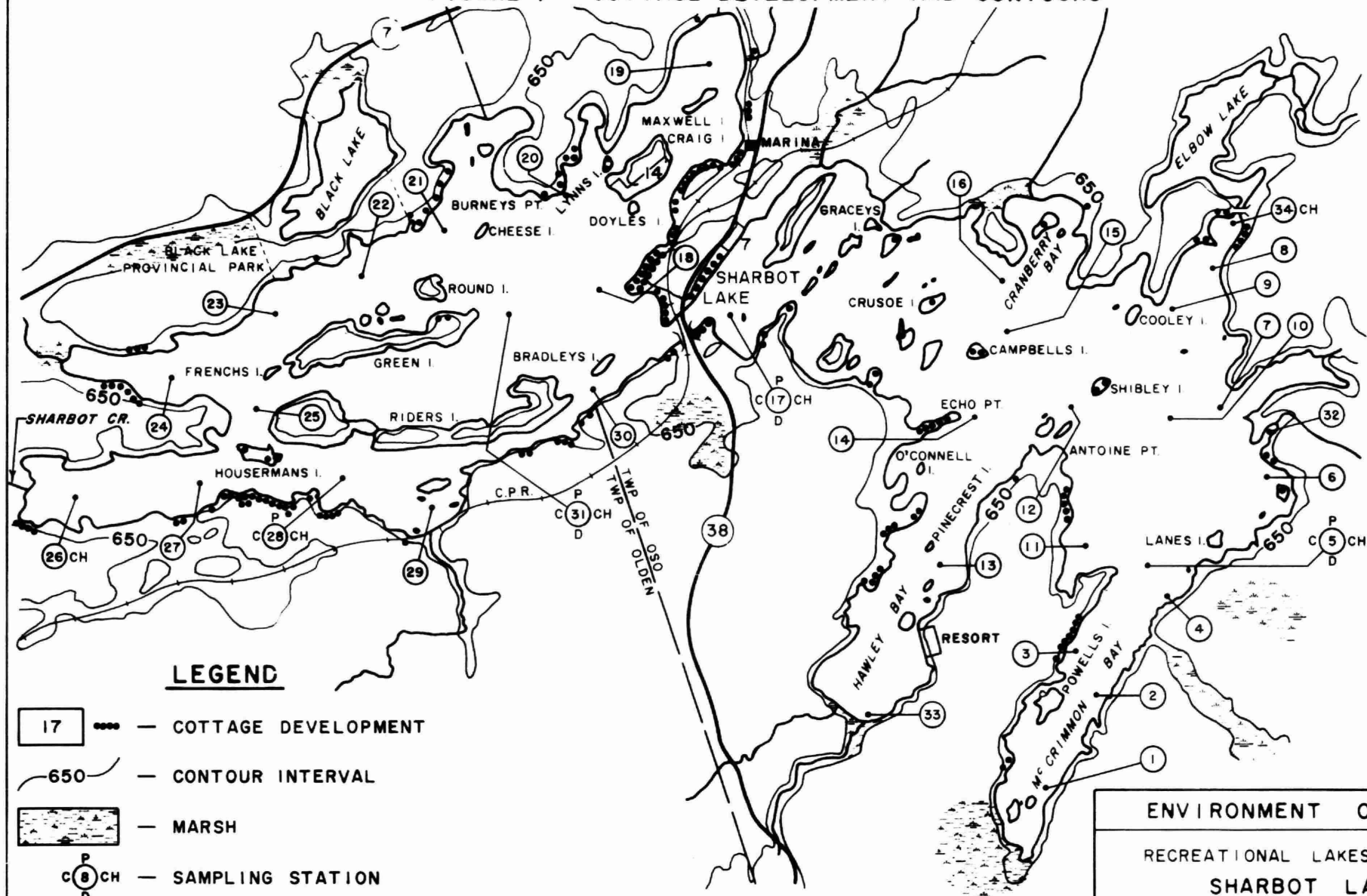
A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over 5 consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Thirty bacteriological samples sites were established over the whole lake (Figure 1) . Chemical samples were collected at the two inlet stations, the outlet station and at three mid-lake stations. In addition to these surface samples chemical and bacteriological samples were taken from the bottom water at the mid-lake stations.

FIGURE 1 - COTTAGE DEVELOPMENT AND CONTOURS



LEGEND

- 17 --- COTTAGE DEVELOPMENT
- 650 --- CONTOUR INTERVAL
- MARSH
- C 8 CH --- SAMPLING STATION
 - C - CHEMICAL SAMPLE
 - P - PROFILE
 - CH - CHLOROPHYLL SAMPLE
 - D - DEPTH STATION

0 1/2 1 MILES

ENVIRONMENT ONTARIO

RECREATIONAL LAKES PROGRAM

SHARBOT LAKE

1972 WATER QUALITY SURVEY

SCALE AS SHOWN

DRAWN BY ARS

DATE JAN, 1973

CHECKED BY

DRAWING NO 73-1-DE

Field Tests

The temperature and dissolved oxygen values were measured at the deep water stations with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc, (Figure 2). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm blooded animals and are found in the colon and feces in tremendous numbers. Hence, these indicator organisms in the water denote the presence of fecal contamination and hence the risk of disease-causing organisms.

Standard plate count (SPC) determinations were made on some mid-lake stations in order to determine densities of some natural water bacteria. The SPC media will only support the growth of those organisms that do not require special nutrients, oxygen requirements and/or incubation temperatures. The SPC is used as a measure of general bacterial activity.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Clear, algae-free lake:
Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake:
Secchi disc readings tend to be less than 3m (9 feet).

Secchi Disc Reading

2 times Secchi disc reading

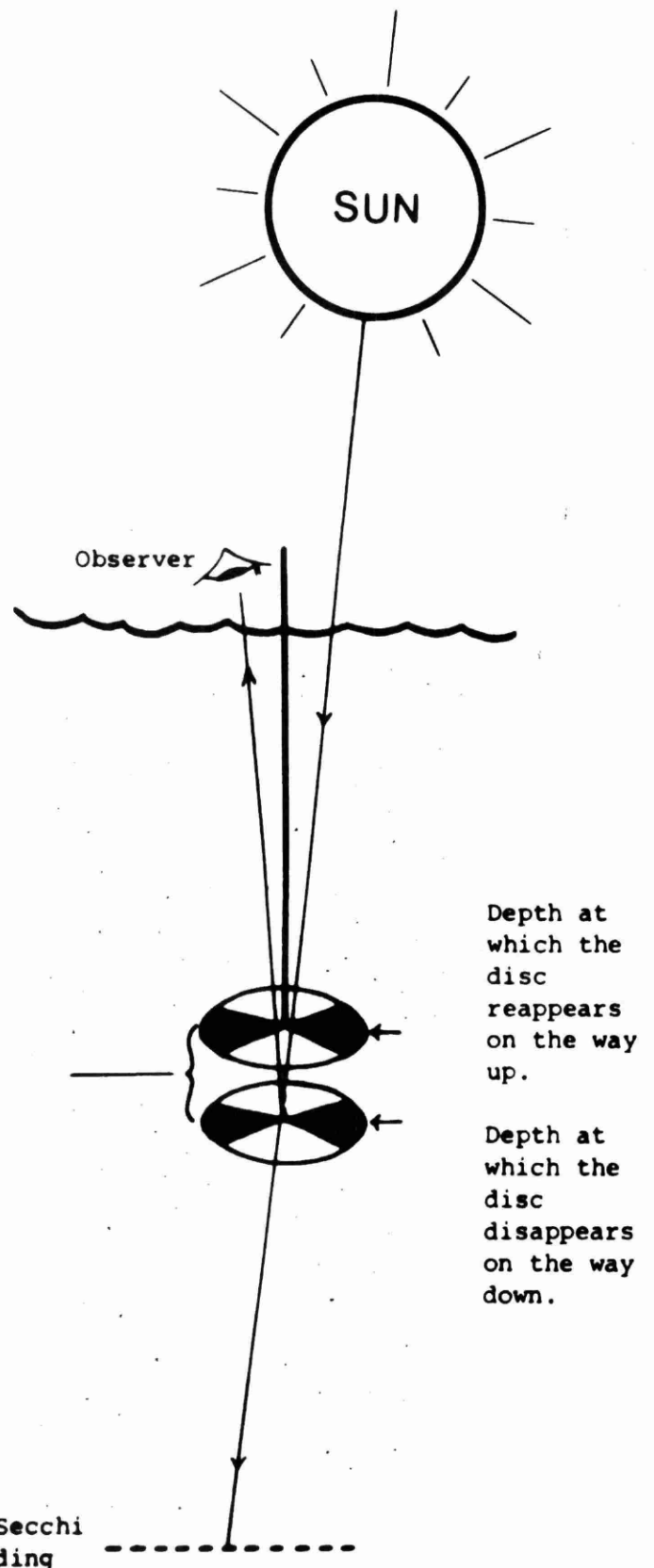


FIGURE 2: USE OF THE SECCHI DISC TO DETERMINE WATER CLARITY.

and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques depend on the mineral content.

Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and bottom water samples. They are particularly important in bottom waters since nitrogen may be regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of algae in the water. The live algae are confined mainly to the lighted surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottle through the depth of this illuminated zone as it filled. The sample was then representative of the average number of algae through the illuminated depth of the surface waters.

DESCRIPTION OF THE SHARBOT LAKE AREA

Lake and Soil Characteristics

Sharbot Lake, located in Olden and Oso Townships, County of Frontenac is approximately 40 kilometers (25 miles) west of Perth.

The lake lies in the Canadian Shield. The area is characterized by rolling hills, poor local drainage, crystalline bedrock, shallow overburden and a number of marsh areas around the lake. The greatest portion of the shoreline soil (Figure 2) is that of Tweed Sandy Loam complex which is a shallow, well-drained calcareous sandy loam with frequent outcroppings of bedrock. The south end of McCrimmon Bay has a shallow mantle of Monteagle soil complex which is similar to the Tweed complex except it is non-calcareous. Due to the insufficient depth of soil cover over the bedrock and to marshy conditions, much of the lake shoreline can be considered unsuitable for installation of standard sub-surface septic tank systems for disposal of domestic wastes.

Sharbot Lake consists of two distinctly separate basins connected by a navigable channel at the Hamlet of Sharbot Lake. For the purpose of this report, the basins will be referred to as East and West Sharbot lakes. Each lake has a very irregular shoreline which is characteristic of most Precambrian Shield lakes.

East Sharbot Lake is very shallow (less than 4 meters) covered with islands with exception of its east arm which reaches a depth of 30 meters (96 feet). Its bottom consists of numerous rocky reefs, shoals and a composition of granitic rubble, mud and silt. This environment is favourable to high productivity of aquatic vegetation and warm water species of fish.

The West Sharbot Lake bottom and shoreline are very irregular and steeply sloping, with granitic rock ledges and 26 islands ranging from 25 to 0.12 hectares

(60 to 0.25 acres) in size. Shoreline and bottom materials are mainly rock and boulders respectively, providing adequate spawning reefs for lake trout. The maximum and the mean depths of this lake are 31 meters and 6.5 meters, respectively. The combined surface area of both lakes is 15 square kilometers (3,725 acres) and their total shoreline including the islands is 76 kilometers (47 miles).

Water Movement

The Sharbot Lake basin drains approximately 100 square kilometers (38.7 square miles) and forms the headwaters of the Fall River which is part of the Mississippi River watershed. The lake has several small inlets at various locations draining the following lakes: White, Bass, Little Round, MacLean's and Black Lake. Its only outlet is through a short watercourse into the Fall River.

Shoreline Development

There are approximately 300 cottages on Sharbot Lake (Figure 1). Most of the cottages are in small groups scattered around the lake with a dense development of cottages and permanent dwellings around the Hamlet of Sharbot Lake. Most of the cottages on the west side of the lake and some on the east side, have a direct road access. The remaining cottages which are not accessible by road are served by a marina park, located on the north shore of West Sharbot Lake. This shore also has a sandy swimming area.

Water Usage

Most cottages use the lake as their source of domestic water supply. Recreational uses of the lake include boating, swimming and angling. The most

popular sport fish is smallmouth bass, especially in East Sharbot. Other sport fish include lake trout in West Sharbot, northern pike, and largemouth bass. According to the Ministry of Natural Resources record, the brown bullhead, a non-game species, is abundant particularly in East Sharbot Lake.

There are no direct discharges of wastes into the lake from communal or municipal sewage treatment facilities. There does not appear to be any pollution from the operation of the existing municipal solids waste disposal site located on Lot 5, Concession I, Oso Township. According to the information available from the Waste Management Branch, Ministry of the Environment, this site was to be upgraded to proper landfill standards during the summer of 1972.

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Bartlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

The results of the three surveys in 1972 indicate that Sharbot Lake in early summer and fall was generally well within the Ministry of the Environment

(MOE 1972) Criteria for Recreational Use. In the summer total coliform (TC) densities generally exceeded the Criteria for Recreational Use which states: "Where ingestion is probable, recreational waters can be considered impaired when the coliform (TC), fecal coliform (FC), and/or enterococcus (FS) geometric mean density exceeds 1000, 100 and/or 20 per 100 ml respectively, ...". (1)

During the early summer survey (Figure 3), TC geometric mean levels, although well within the Criteria for all stations of the lake, were not uniformly distributed throughout the lake. The majority of stations (Group A) had a low TC mean of 13/100 ml while stations within the influence of an inlet at the west end of the lake (Group B), had a higher mean of 34 TC/100 ml. The mid-Channel station in close proximity to the Sharbot Lake village development (Station 17) and a west inlet station (Station 26) had higher TC means of 56 and 124 TC/100 ml respectively.

Both FC and FS densities throughout this survey were exceedingly low with means of 1/100 ml, with the exception of Station 26 which had 3 FC/100 ml and stations 13, 17, and 29 which had FS means of 2, 7, and 4/100 ml respectively. The entire lake was homogeneous for FC and at no time during this survey did the FC or FS means exceed the MOE Criteria.

In the July-August survey (Figure 4), the TC means for most stations (Group A) were 1030 TC/100 ml and exceeded the MOE Criteria. A north-west area adjacent to some cottage development and situated on light soil cover (Station 21) had extremely high TC means of 3577/100 ml, exceeding the MOE Criteria. However, these high TC levels are not considered hazardous since the FC means were homogeneously low at 1/100 ml. At no time did any station on any day of

(1) Guidelines and Criteria for Water Quality Management in Ontario. MOE 1972.

FIGURE 3 - BACTERIOLOGICAL SURVEY - JUNE 7 TO JUNE 11

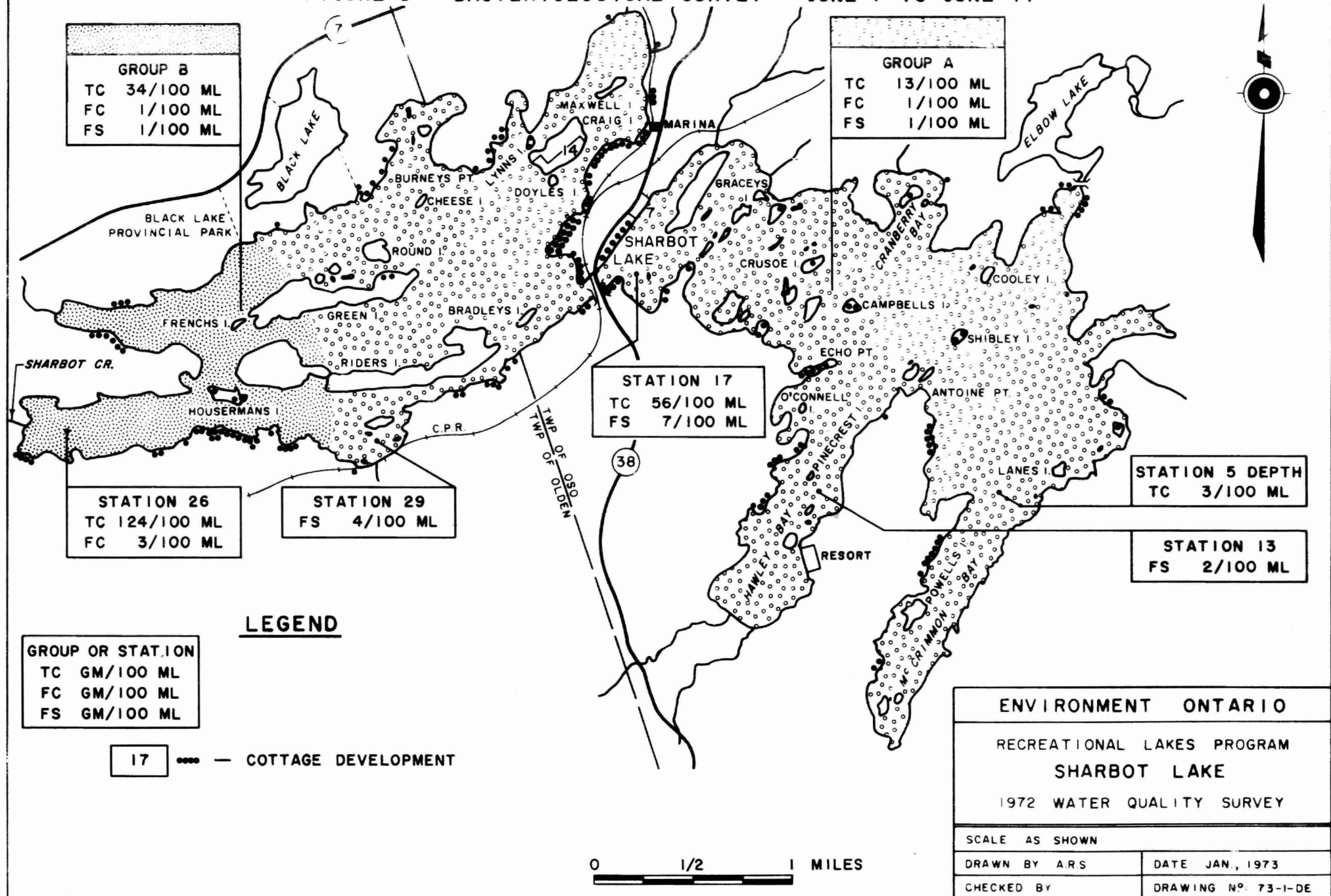


FIGURE 4 - BACTERIOLOGICAL SURVEY - JULY 31 TO AUG. 4

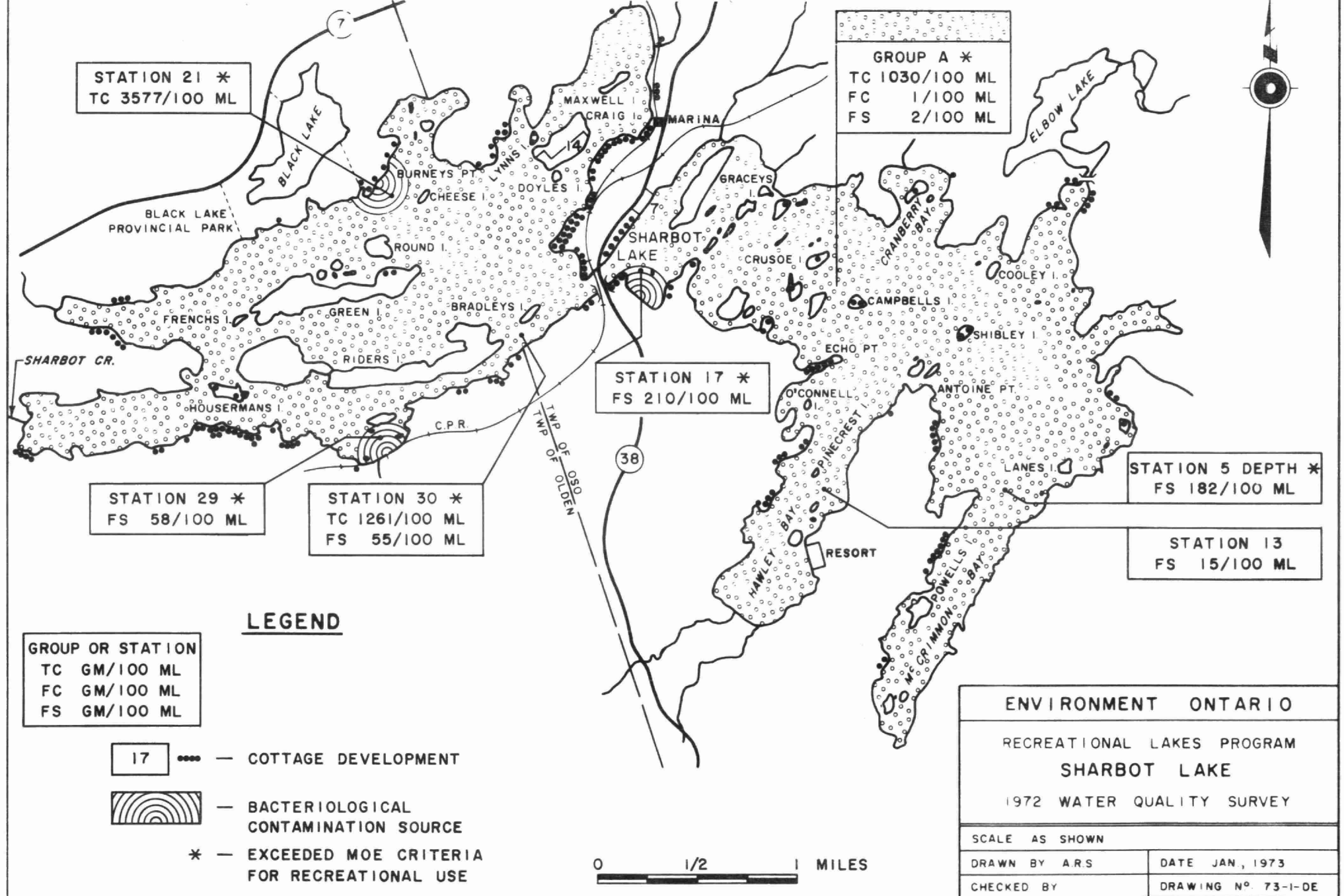
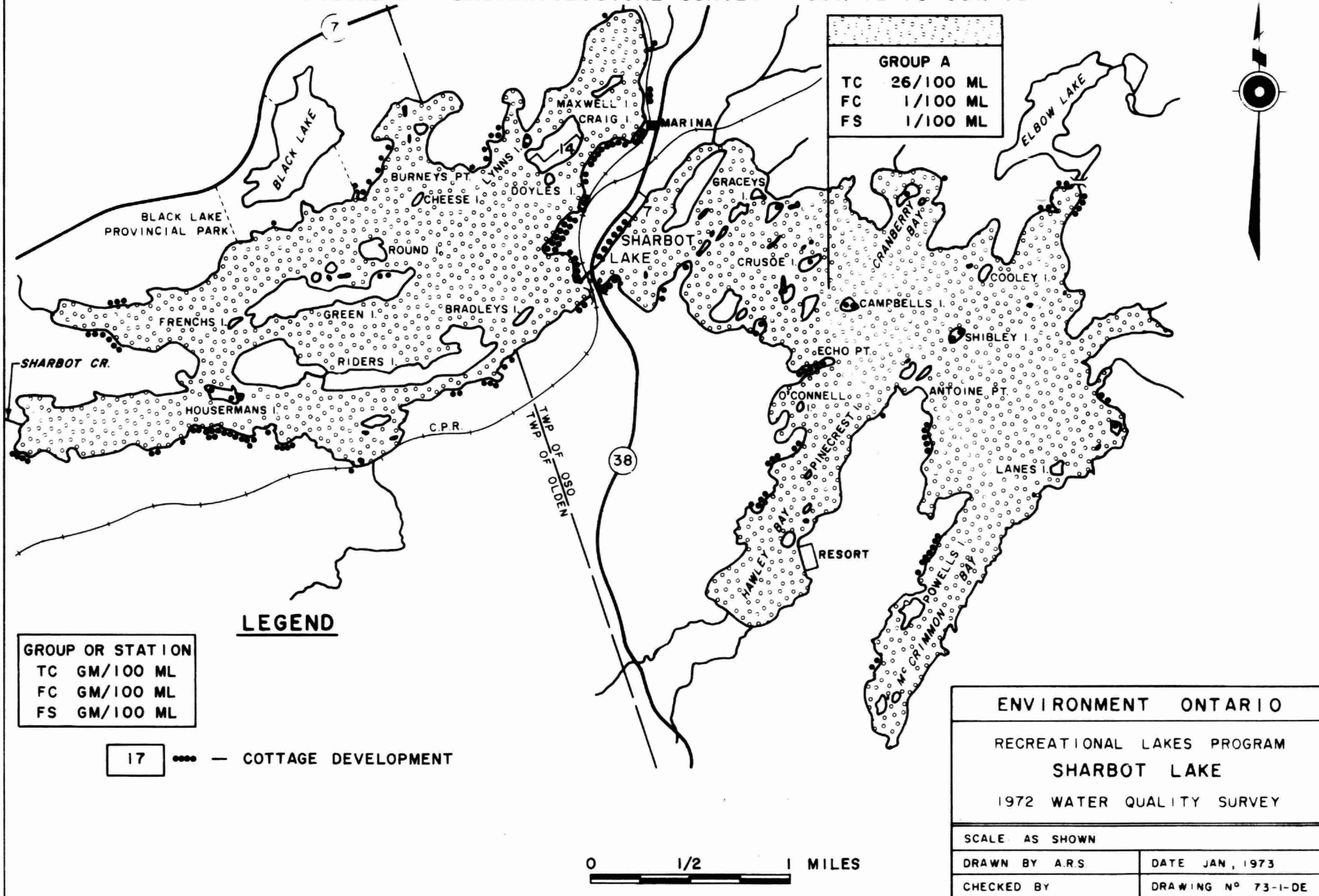


FIGURE 5 - BACTERIOLOGICAL SURVEY - OCT. 12 TO OCT. 16



the survey have FC densities that approached the MOE Criteria. Most stations on the lake (Group A) had mean FS concentrations of 2 FS/100 ml. However, areas in the immediate vicinity of the Sharbot Lake development (Station 17) had a mean of 210 FS/100 ml and exceeded the Criteria by severalfold. The moderately developed bay in the western basin of the lake (Station 29) and the area just south of Bradley's Island (Station 30) had densities of 58 and 55 FS/100 ml respectively.

In October, mean bacterial concentrations for most stations (Group A) were low at 26 TC, 1 FC, and 1 FS/100 ml (Figure 5). At no time during this survey did the mean bacterial densities at any station exceed the MOE Criteria.

Standard Plate Count (SPC) densities at depth stations 5, 17, 22, 28 and 31 during the June survey were 500, 500, 300, 1500 and 600/100 ml respectively. In the July-August survey the SPC means were 500, 6300, 9300, 13,900 and 18,500/100 ml respectively while means of 300, 1100, 1900, 3700 and 500/100 ml were recorded for these stations during the October survey.

Chlorophyll a and Water Clarity

As indicated by chlorophyll a concentrations, all deep-water sampling stations were characterized by small amounts of suspended algae in the illuminated zone of the lake on all three surveys. Concentrations of chlorophyll a were frequently less than 1 ug/l especially during the October survey, while concentrations approaching 4 ug/l were not uncommon during June. Mean chlorophyll a concentration over the three surveys at the five deep-water stations (stations 5, 17, 22, 28 and 31) was 1.8 ug/l. Similarly the mean Secchi disc reading at the deep-water stations of 3.5m indicates water of good clarity.

On a scale of lake enrichment as indicated by chlorophyll a concentrations and water transparency Sharbot Lake is moderately enriched but far removed from such highly enriched and productive waters as the Bay of Quinte (Figure 6). Larger amounts of suspended algae and decreased water transparency are probably limited by lack of nutrients.

Chemistry

Temperature and dissolved oxygen profiles are shown in Figures 7, 8 and 9. Station 28, which is close to Sharbot Creek had a very low dissolved oxygen concentration in the bottom water during June and August. Bottom water oxygen was re-established at saturation values during the fall overturn which occurred prior to the October survey at this station. Station 5, in the east basin of the lake, has been previously reported by Cooper (Ontario Department of Lands and Forests Survey of 1970) to be oxygen deficient. In 1972, it contained 6 mg/l dissolved oxygen at the beginning of the survey in June, but by October it had no dissolved oxygen below 15 meters depth at which depth there was a temperature gradient. Stations 22 and 31 in the west basin showed a gradual oxygen depletion in the bottom waters over the survey period reaching a level of 1 mg/l or less during October. These low oxygen values in the colder waters of the lake render both east and west Sharbot Lake an adverse habitat for any cold water fish species.

Sharbot Lake is a moderately hard water lake with a hardness of 95-100 mg/l which is similar to Lake Huron (90-110 mg/l).

Alkalinity (89 mg/l as CaCO_3) and hardness changed very little throughout the open lake during the survey.

Chloride, at 8 mg/l, was a minor mineral constituent and is uniform throughout the lake.

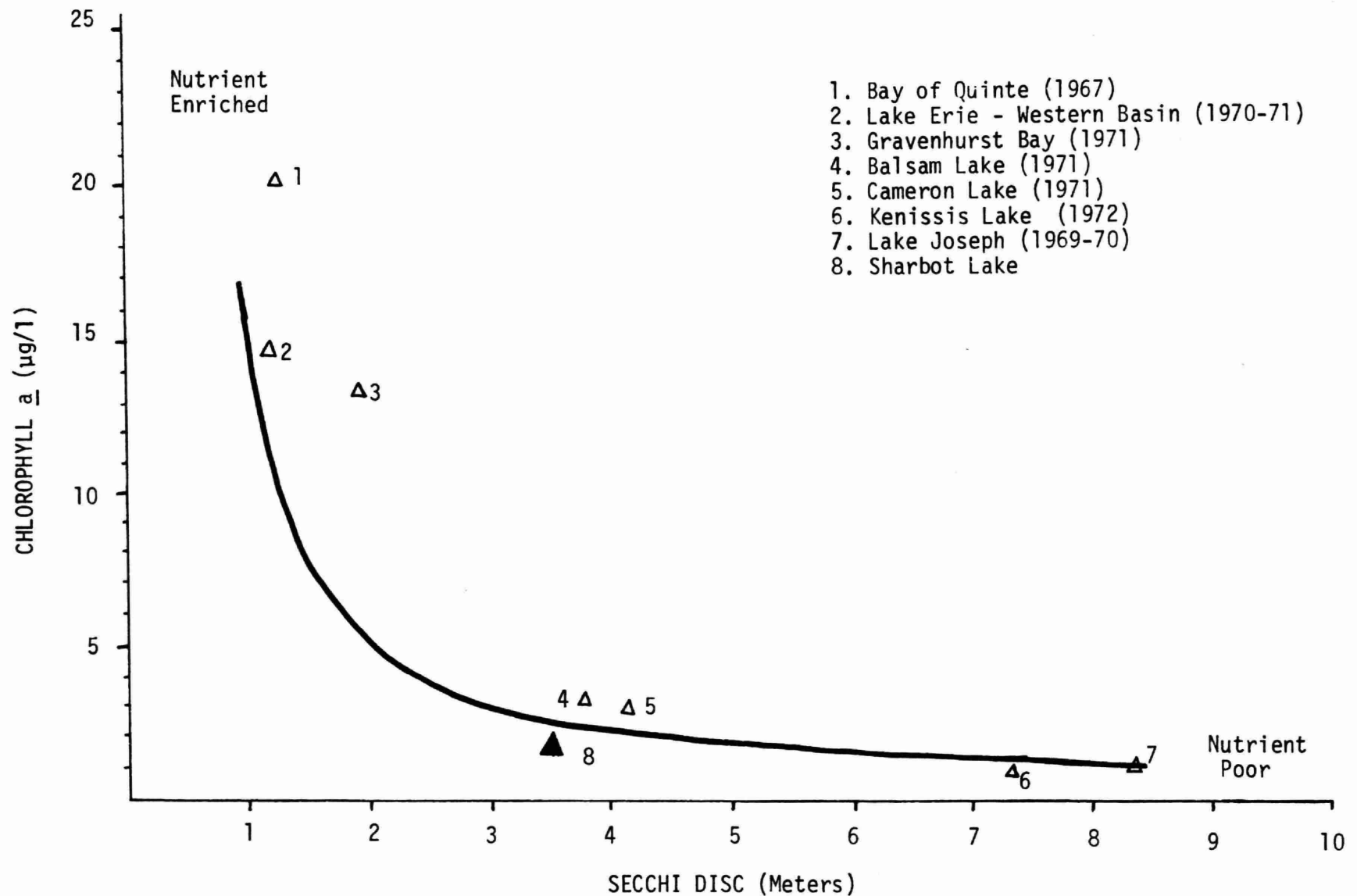


Figure 6: The mean of chlorophyll a and Secchi disc measurements in Sharbot Lake relative to a curve describing the chlorophyll a - Secchi disc relationship in many Ontario lakes. Seven other well known lakes are included for comparison with Sharbot Lake.

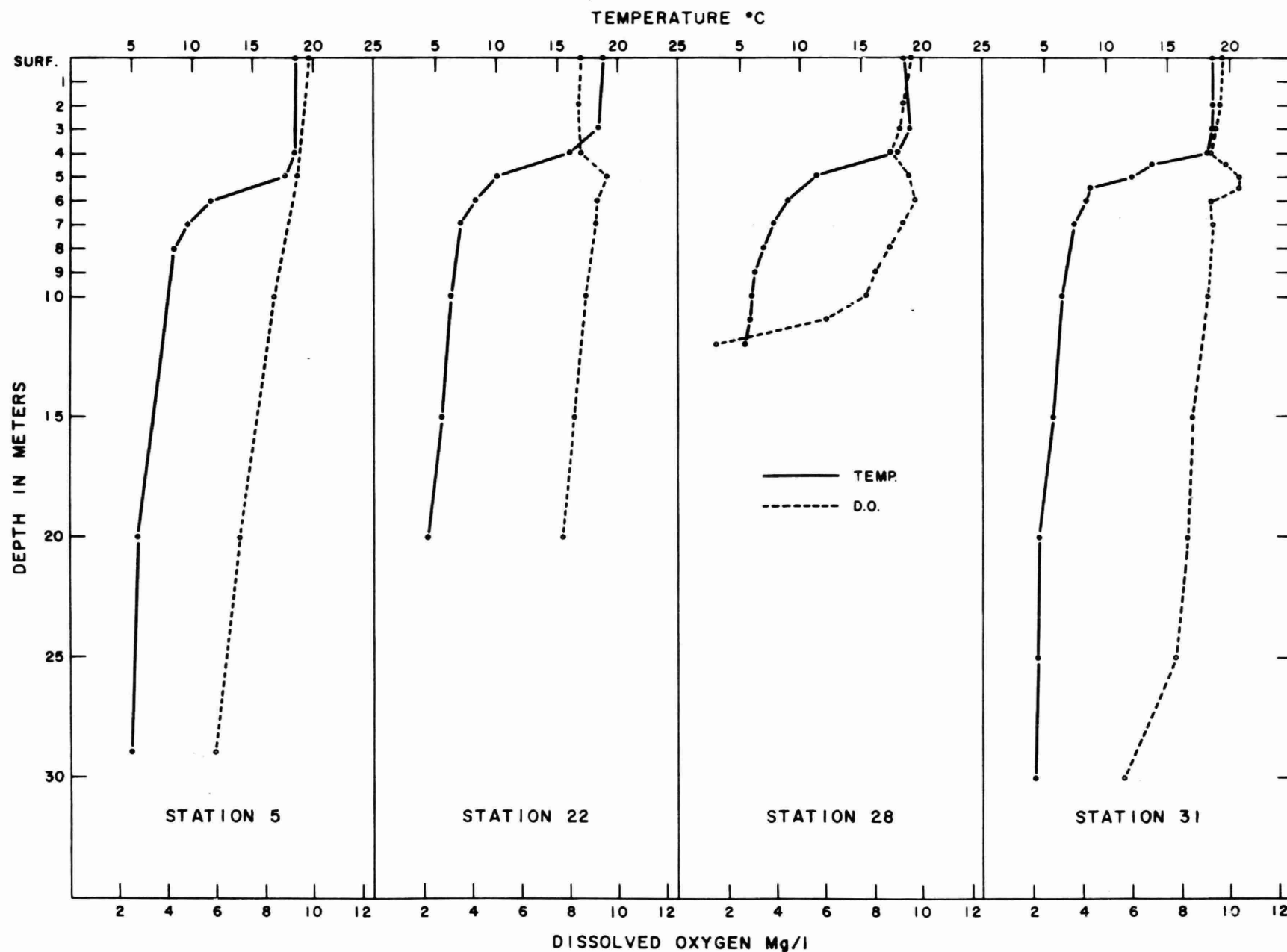


FIGURE 7 - DISSOLVED OXYGEN AND TEMPERATURE PROFILES AT STATIONS 5, 22, 28 & 31 DURING THE JUNE SURVEY

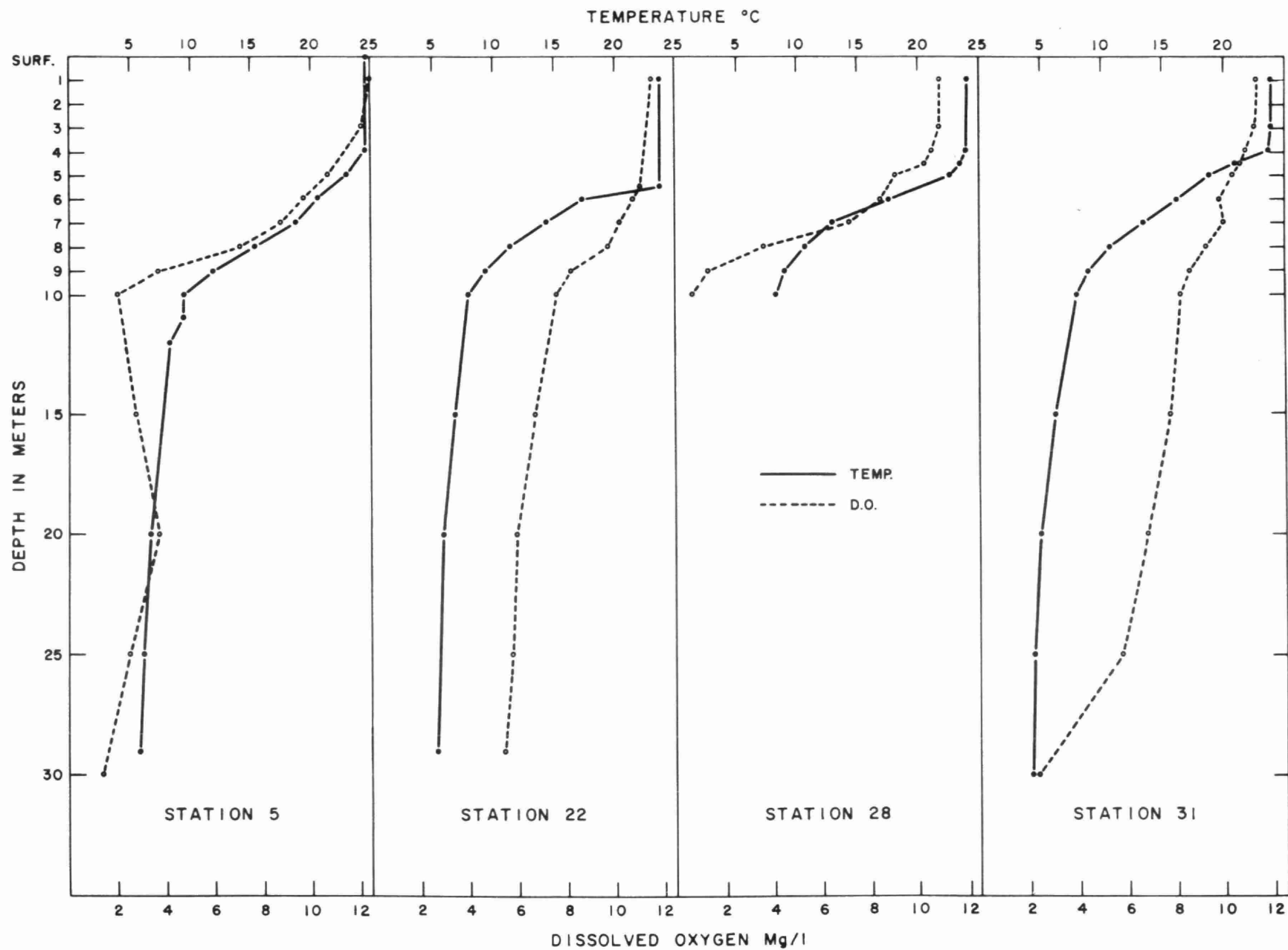


FIGURE 8 - DISSOLVED OXYGEN AND TEMPERATURE PROFILES AT STATIONS 5, 22, 28 & 31 DURING THE AUGUST SURVEY

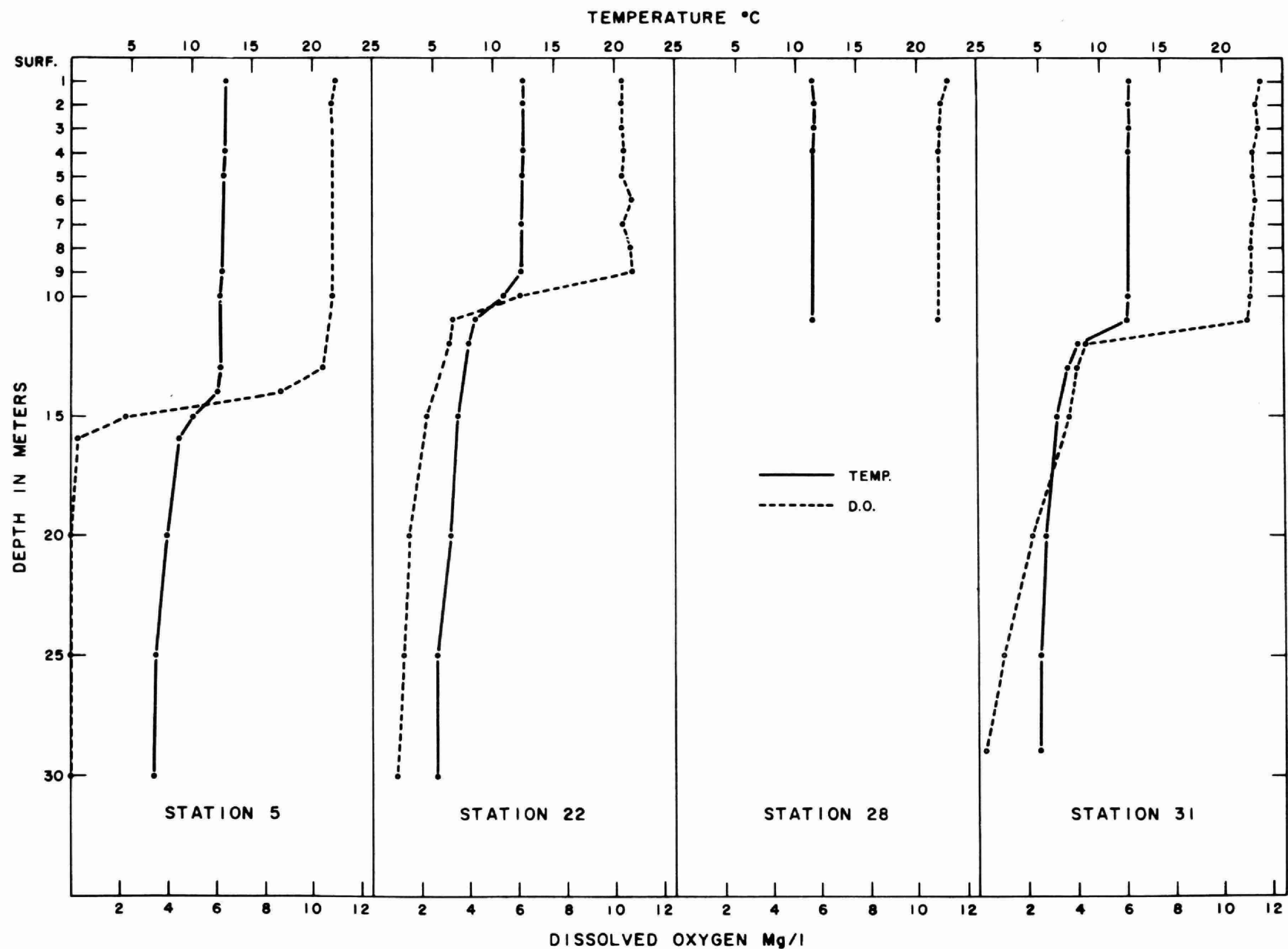


FIGURE 9 - DISSOLVED OXYGEN AND TEMPERATURE PROFILES AT STATIONS 5, 22, 28 & 31 DURING THE OCTOBER SURVEY

Iron was quite low at .05 to .1 mg/l except for one bottom water sample in the deepest part of the lake which contained 0.9 mg/l.

Nitrogen and phosphorus concentrations in the open lake were generally low with some moderate phosphorus concentrations recorded at the end of the July survey.

Nitrate values in the bottom waters were in the 0.10 - 0.20 mg/l range while there was still oxygen present. Nitrate declined to less than 0.010 mg/l when the bottom water became anoxic.

Sharbot Creek inlet Station 26 showed a wide fluctuation in water chemistry throughout the survey period. Hardness and alkalinity values for this station were generally higher than for the rest of the lake. Iron was up to 0.06 mg/l during the June survey. Total phosphorus and Kjeldahl nitrogen values at this station ranged up to 5 times the concentration in the lake. There was no evidence of increased chloride which would be indicative of a sewage source for the increased nitrogen and phosphorus nor was there measurable nitrate which would come from a chemical fertilizer. It is probable, therefore, that the increase in total phosphorus and Kjeldahl nitrogen at the Sharbot Creek station are due to natural run-off.

Surface water pH values reached a high of 8.4 during the August survey with 7.9 to 8.0 values recorded during the June and October surveys. Bottom water pH values of 6.9 to 7.0 were uniformly lower than corresponding surface values due to CO₂ production from the sediments.

One exception was Station 28 which had mixed before the October survey and had uniform pH at the surface and bottom.

Future Considerations

Although Sharbot Lake was considered to have fairly good water quality, there is no room for complacency. Analyses of surface and depth samples taken at stations 22 and 31 during the October survey failed to show any evidence of sulfate reducing bacteria, or any evidence of hydrogen sulfide odour. This suggests that the observed anaerobic conditions were not severe enough to give rise to extensive sulfate reduction and hydrogen sulfide production. In order to avoid more severe anaerobic conditions and possible odour problems it is essential that there should be no disposal of wastes which would cause an increase in the nutrient or organic content of Sharbot Lake.

INFORMATION OF GENERAL INTEREST TO COTTAGERS MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria do not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis but he may catch lesser infections of gastroenterities (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These virus infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic matter in the lake will be used as food by these organisms and will be used as food

by these organisms and will give rise, in turn, to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amount of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH
per 10 ft depth of water

Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

- 50 feet to any well, lake, stream or pond.
- 5 feet to any building.
- 10 feet to any property boundary

The tile field should not be closer than:

- 100 feet to the nearest dug well.
- 50 feet to a drilled well which has a casing to 25 feet below ground.
- 25 feet to a building
- 10 feet to a property boundary.
- 50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1.1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. Fuel hoses must be in good condition and all connections tight.
4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.
5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscriminate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with

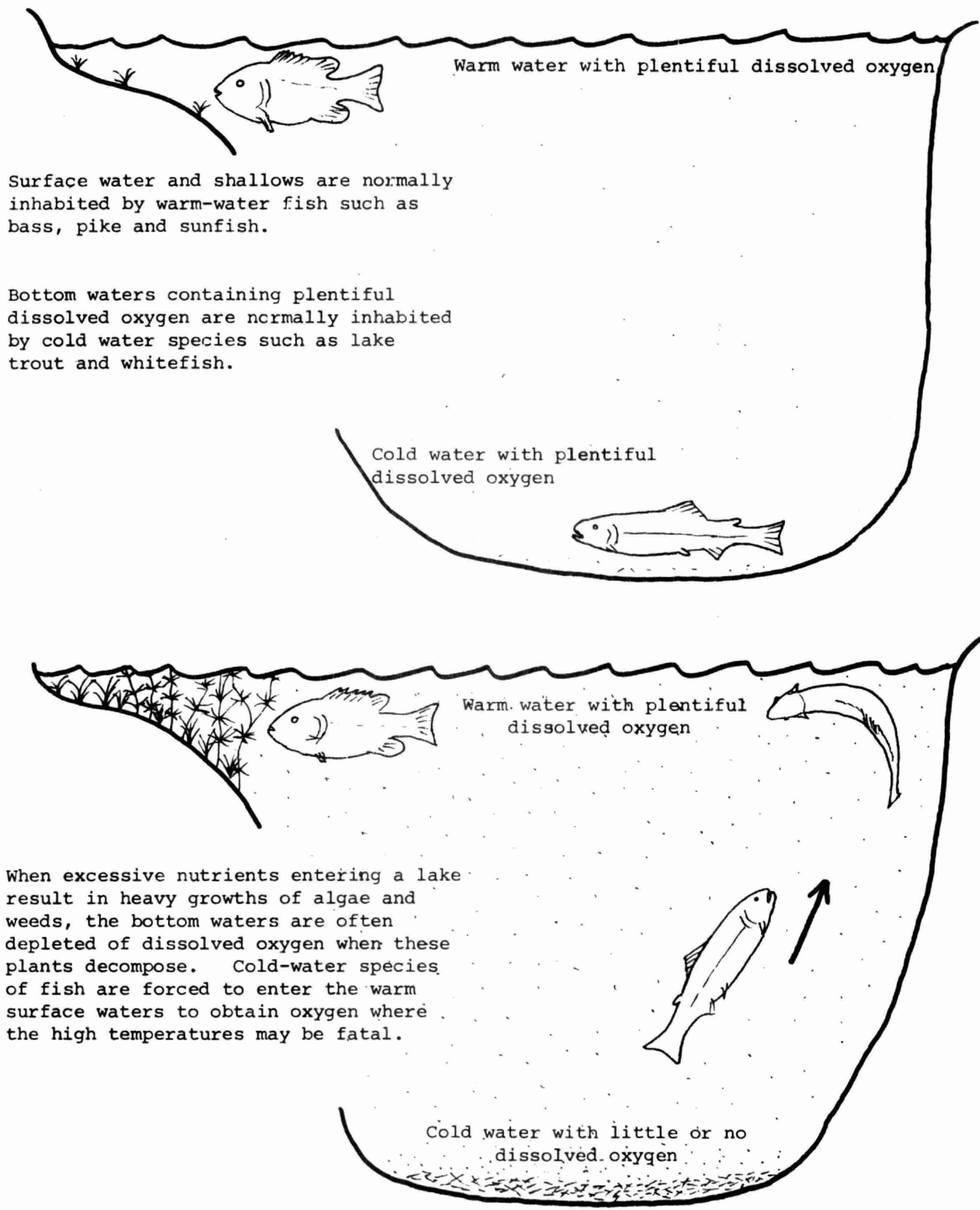


FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.